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In re Application of: François SAWYER

For: METHOD AND DEVICE FOR ATTENUATING AN INTERFERER FROM A
COMMUNICATION SIGNAL

BOX APPLICATION
Assistant Commissioner
for Patents
Washington, D.C. 20231

Sir:

PATENT APPLICATION TRANSMITTAL LETTER

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- ☒ Specification, claims and abstract of the above-referenced patent application (total of 40 pages).
- ☒ 5 sheet(s) of drawing(s) (☐ formal / ☒ informal).
- ☒ Combined Declaration and Power of Attorney.
- ☒ An Assignment of the invention to : Telefonaktiebolaget L M Ericsson
- ☐ _____ A verified statement claiming small entity status under 37 CFR 1.9 and 1.27.
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**METHOD AND DEVICE FOR ATTENUATING AN
INTERFERER FROM A COMMUNICATION SIGNAL**

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BACKGROUND OF THE INVENTION

10 1. Field of the invention:

The present invention relates to the field of communications and more specifically to the attenuation of an unwanted interferer signal from a communication signal.

15

2. Brief description of the prior art:

In a cellular telephone system, CDMA (Code Division
20 Multiple Access), including IS-95 and WCDMA (Wideband Code Division Multiple Access), offers an inherent protection against narrowband interference. CDMA relies on a despread-
ing operation to minimise the interference effects of undesired signals, including noise. However, this protection has a cost since it often requires a higher transmission power
25 in order to provide the receiver with sufficient gain over the interference, i.e. to provide the required minimum signal-to-noise ratio. This requirement for higher transmission power reduces the range and the

capacity of the network. On the uplink side, this also reduces the mobile station battery duration.

In an article entitled "CDMA-IC: A NOVEL CODE
5 DIVISION MULTIPLE ACCESS SCHEME BASED ON INTERFERENCE
CANCELLATION", and published by IEEE (Institute of Electrical and
Electronics Engineers) in 1992, Paul DENT, Björn GUDMUNDSON and
Magnus EWERBRING disclose a method for reducing interference in the
CDMA signal of one user caused by the CDMA signals of the other users.
10 For that purpose, the user received at higher signal strength is first
identified and despread, and this despread signal is subtracted from the
composite signal. Thus, for other users' signals not yet despread,
interference is made less significant, and their signal-to-noise ratio is
improved. Obviously, this method attenuates only interference related to
15 other CDMA users' signals.

In PCT international patent application published under
No. WO 99/38270 on July 29, 1999, Terence WIDDOWSON proposes an
apparatus for decoding a spread spectrum signal which has been
20 transmitted via a transmission channel. This spread spectrum signal
comprises a wanted spread spectrum signal component and an unwanted
narrowband signal component. The narrowband signal has been coded
using a coding scheme with error correction capabilities. This apparatus
includes a narrowband signal subtractor in which:

- the composite signal is decoded and corrected according to the narrowband signal coding scheme to provide a decoded version of the narrowband signal;
- the amplitude and phase characteristics of the transmission channel are estimated;
- the decoded corrected signal is encoded according to the narrowband signal coding scheme to produce an estimated narrowband signal;
- the phase and amplitude of the estimated narrowband signal are adjusted according to the estimate amplitude and phase characteristics; and
- the adjusted signal is subtracted from the received composite signal to provide an estimate of the spread spectrum signal component.

The narrowband coding scheme can also detect uncorrectable errors. Upon detection of an uncorrectable error, the above mentioned subtraction is suppressed and the frequencies of the composite signal corresponding to the narrowband signal component are attenuated.

Therefore, the apparatus of PCT international patent application WO 99/38270 requires:

- decoding and correction of the composite signal;
- estimation of the amplitude and phase characteristics of the transmission channel;

- encoding of the decoded corrected signal according to the narrowband signal coding scheme;
to produce an estimated narrowband signal.

5 Document EP 0 967 734 A2 (Suzuki) published on December 29, 1999 relates to a DS-CDMA multiuser interference canceller for processing a received signal containing CDMA spread signals from a plurality of users. The function of this canceller is to remove, from the signal of each user, signals of other users and thereafter
10 decode the signal of this specific user. This obviously eliminates interference caused by the spread signal of the other users.

For that purpose, interference replica signals identical to signal components of the users are generated from a received composite
15 signal and, for every user, the interference replica signals from the other users are subtracted from the received composite signal.

When subtraction of the interference replica signals from the composite signal does not improve reception quality, outputting of
20 these interference replica signals is turned off. Reception quality may be monitored through BER measurement.

Alternatively, a control process can be used to control the level of the interference replica signals, rather than controlling turning on
25 and off of the interference cancellation process.

Again, processing of the received composite signal is required to obtain the interference replica signals. Also, adjustment of the level of the interference replica signal is made according to a predetermined pattern. More specifically, according to the teaching of this document, the level of the interference replical signal is increased with time so that the interference cancellation process is less susceptible to the effect of the delay in a control process.

OBJECTS OF THE INVENTION

An object of the present invention is to use the substantially known spectrum of an interferer to generate an image of this interferer independently of a received communication signal.

Another object of the present invention is to use a plurality of images having different features and a selection of one of these images which best attenuates the interferer.

A third object of the present invention is to use a feedback controlled image of the interferer to optimize attenuation of the interferer.

SUMMARY OF THE INVENTION

More specifically, in accordance with the present
5 invention, there is provided a method for attenuating an interferer of
substantially known spectrum in a communication signal which has been
transmitted through a transmission channel and processed through a
signal-processing receiver chain. This method comprises generating, from
the substantially known spectrum and independently of the communication
10 signal, at least one image representative of a replica of the interferer after
processing through the signal-processing receiver chain. The image is
subtracted from the processed communication signal to produce a
subtraction signal, a quality-indicative parameter of the processed
communication signal is calculated, and the quality-indicative parameter
15 for the subtraction signal is computed. Finally, the method selects, in
relation to the quality-indicative parameters, one of the processed
communication signal and subtraction signal for further processing through
the receiver.

20 According to preferred embodiments of the above
method:

- the interferer is a narrowband AMPS interferer, the communication signal
is a CDMA spread spectrum signal, the signal-processing receiver chain
25 incorporates a despreading scheme whose function is to convert the
spread spectrum signal to a despread signal, and the replica is a silent

replica of the interferer including no voice of data component; and

- the quality-indicative parameters are BER measurements of the despread signal and subtraction signal.

5

The present invention also relates to a method for attenuating an interferer from a communication signal which has been transmitted through a transmission channel and processed through a signal-processing receiver chain, wherein, a plurality of images of the
10 interferer having different features are generated, for each interferer image the interferer image is subtracted from the processed communication signal to produce a corresponding subtraction signal, a quality-indicative parameter of the processed communication signal is calculated, and the quality-indicative parameter is calculated for every subtraction signal. The
15 method finally comprises selecting, in relation to the quality-indicative parameters, one of the processed communication signal and subtraction signals for further processing through the receiver.

Preferably, the features of the images comprises
20 amplitudes of these images.

The present invention is further concerned with a method for attenuating an interferer from a communication signal which has been transmitted through a transmission channel and processed through a
25 signal-processing receiver chain, comprising generating an image of the interferer, subtracting the interferer image from the processed

communication signal to produce a subtraction signal, calculating a quality-indicative parameter of the processed communication signal, computing the quality-indicative parameter for the subtraction signal, and selecting, in relation to the quality-indicative parameters, one of the
5 processed communication signal and subtraction signal for further processing through the receiver. At least one feature of the image of the interferer is feedback controlled in relation to the quality-indicative parameter of the subtraction signal in view of improving this quality-indicative parameter of the subtraction signal.

10

Preferably, this feedback control takes into consideration the selection to improve the quality-indicative parameter of the subtraction signal until the subtraction signal is selected for further processing through the receiver.

15

The present invention also provides corresponding devices for implementing the above defined interferer attenuating methods.

20

Finally, the present invention relates to a method of generating an image of an interferer of substantially known spectrum for use in attenuating this interferer in a communication signal which has been transmitted through a transmission channel and processed through a signal-processing receiver chain. This method comprises generating a
25 replica of the interferer from the substantially known spectrum and independently of the communication signal, and processing the interferer

replica through transfer functions reproducing the signal-processing receiver chain in view of producing the interferer image.

5 Preferably, a gain is applied to the processed interferer replica. Also, both generating of an interferer replica and processing of the interferer replica can be conducted through a digital implementation such as software, firmware (e.g. PROM (Programmable Read-Only Memory)), ASIC (Application Specific Integrated Circuit).

10 Other objects, advantages and features of the present invention will become more apparent upon reading of the following non-restrictive description of preferred embodiments thereof, given by way of example only with reference to the accompanying drawings.

15

BRIEF DESCRIPTION OF THE DRAWINGS

20

In the appended drawings:

Figure 1 is a schematic flow chart showing the general principle of operation of a CDMA communication scheme in a cellular telephone network;

Figure 2 is a graph illustrating the spectrum of an IS-95 or WCDMA wideband signal interfered by a narrowband AMPS interferer;

Figure 3 is a graph illustrating the IS-95 or WCDMA wideband signal and the narrowband AMPS interferer of Figure 2 after processing through a CDMA despreading scheme;

Figure 4 is a schematic block diagram of a generator for producing an image of the narrowband AMPS interferer of Figure 2;

10

Figure 5 is a schematic block diagram of a first preferred embodiment of a device for attenuating the AMPS interferer from the IS-95 or WCDMA communication signal following despreading thereof; and

15

Figure 6 is a schematic block diagram of a second preferred embodiment of a device for attenuating the AMPS interferer from the IS-95 or WCDMA communication signal following despreading thereof.

20

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

Although the preferred embodiment will be described with reference to CDMA communication in a cellular telephone system, it should be kept in mind that the present invention is not limited to this particular application.

As illustrated in Figure 1, a CDMA transmitter 1 receives a baseband signal 10 containing, for example, "voice" or other signal of interest. The CDMA transmitter 1 then conducts a convolution 11 of this
5 baseband signal 10 with a CDMA spreading code PN_{code1} identified by the reference 12 in Figure 1. As well known to those of ordinary skill in the art, the convolution 10 with the spreading code PN_{code1} 12 spreads the spectrum of the baseband signal 10 to produce a wideband communication signal 13 (spread spectrum signal) subsequently
10 transmitted over a transmission channel 14. In the case of a cellular telephone system, the transmission channel 14 uses air as transmission medium.

During transmission over the transmission channel 14,
15 the wideband communication signal 13 can accumulate noise of all types. The wideband signal 13 can also be subjected to narrowband interference such as an AMPS (Advanced Mobile Phone System) signal. Finally, other CDMA wideband signals (each resulting from convolution of a baseband signal with another CDMA code PN_{codeX}) transmitted
20 through a common transmission medium, such as air, can add to the wideband signal 13. Just a word to recall that narrowband AMPS can have a high power and coexist with CDMA in the North American frequency spectrum.

25 A CDMA receiver 2, for example located in a base or mobile station of a cellular telephone system, accordingly receives a

wideband signal 15 charged with noise of many types, and eventually narrowband AMPS interference and interference from other CDMA wideband signals.

5 The receiver 2 comprises receive and IF (Intermediate Frequency) filters 16 conventionally used to isolate as much as possible the original wideband signal 13 from the received, adjacent spectrum interference (not shown). The signal from the filters 16 is subjected to a convolution 17 with the original CDMA spreading code PN_{code1} 12 to
10 despread the spectrum of the wideband signal 15 (despread signal) and thereby recover a baseband signal 18 incorporating the original baseband signal 10 contaminated with the above mentioned noise, narrowband interference and interference from other CDMA wideband signals.

15 CDMA transmission of signals through the transmission channel 14 is otherwise well known to those of ordinary skill in the art and accordingly, will not be further described in the present specification.

20 The preferred embodiment of the present invention is concerned with handling of a narrowband AMPS interferer in a CDMA transmission system.

25 Referring to Figure 2, which illustrates an example of a CDMA wideband signal 15 containing a narrowband interferer 20. In the illustrated example, the CDMA wideband signal 15 comprises a spread

spectrum IS-95 or WCDMA signal 13 and a narrowband AMPS interferer 20.

As illustrated in Figure 3, processing of the CDMA
5 wideband signal 15 through the filters 16 and convolution 17 thereof with
the CDMA spreading code 12 despreads the spectrum of the CDMA
wideband signal 13 to regenerate the baseband signal 10, including voice
or other signal of interest, and spreads the spectrum of the AMPS
narrowband interferer 20. In this way, the baseband signal 10 has a
10 higher signal level 30 while the interferer 20 has a lower interferer signal
level 31. Therefore, the power level of the baseband signal 10 of Figure
3 is higher than the power level of the interferer 20.

Of course, an established, minimum signal-to-noise ratio
15 32 (Figure 3) is required to ensure adequate communication. When the
AMPS interferer 20 has too high a power level, the transmitter such as a
mobile station of a cellular telephone system has to increase its
transmission power to ensure a sufficient signal-to-noise ratio. This
reduces the battery duration of the mobile station, this reduces the range
20 of transmission since the power output of the mobile station is limited, and
this obviously reduces the overall capacity of the cellular telephone
system.

The present invention makes use of the knowledge of the
25 interferer to cancel at least some components of this interferer. In the

presently described preferred embodiment, a CDMA wideband signal is believed to be interfered by an AMPS signal.

For that purpose, an image of the AMPS interferer is first
5 generated. Since the spectrum of the AMPS interferer is substantially known, this can be made through an image generator as illustrated in Figure 4 independently the wideband signals 13 and/or 15.

It is usually correct to assume that speech is absent from
10 an AMPS signal 60% of the time. Therefore, an AMPS replica 40 (Figure 4) wanted to have as much as possible the same spectrum as the AMPS interferer 20 is generated by an AMPS replica sub-generator 41 in the CDMA receiver 2, assuming that the AMPS signal comes from a silent user. As indicated in the foregoing description, this is a true assumption
15 for 60% of the time. This locally generated silent AMPS replica 40 will become an "image" of the AMPS interferer.

Still referring to Figure 4, the silent AMPS replica 40 is processed through the same transfer functions as the transfer functions
20 imposed by the receiver to the wideband signal 15 including the AMPS interferer 20.

More specifically, the silent AMPS replica 40 is filtered by receive and IF filters 42 similar to the receive and IF filters 16 of the
25 CDMA receiver 2 to produce a filtered silent AMPS signal 43. Then, convolution 44 of the filtered AMPS signal 43 with the same CDMA code

PN_{code1} 12 is performed to spread the spectrum of the filtered silent AMPS
signal 43 and produce a spread spectrum silent AMPS signal 45. Finally,
a gain (for example amplifier 46), adjustable or not, is applied to the
spread spectrum silent AMPS signal 45 to produce the image 47 of the
5 AMPS interferer 20.

Production of the image 47 does not need to be
implemented as illustrated in Figure 4. Of course, a digital implementation
of the image generator of Figure 4 can be built through software, firmware
10 (e.g. PROM (Programmable Read-Only Memory)), ASIC (Application
Specific Integrated Circuit) implementing the AMPS modulation and the
necessary transfer functions.

Figure 5 illustrates a first implementation of a method
15 and device for attenuating, that is removing at least some components of
the AMPS interferer 20 from the baseband signal 18 (Figure 1).

The baseband signal 18 is first produced by processing
the wideband signal 15 of Figure 1 through the CDMA receiver chain 50,
20 including the filters 16 and convolution 17 of the CDMA receiver 2 (Figure
1).

Bit error analysis is performed in a BER (Bit Error Rate)
measurement module 51 on the baseband signal 18 and the resulting
25 BER ratio is applied to a corresponding input of a selector 52. Bit error
rate analysis measures the ratio of the amount of erroneous bits of a

message to the total number of bits of the message received. Also, the BER ratio provides an estimation of the signal-to-noise ratio. Accordingly, the BER ratio constitutes a quality-representative parameter of the signal on which bit error analysis is performed.

5

At least one image generator 53 uses the scheme of Figure 4 or a corresponding digital implementation such as software, firmware (e.g. PROM (Programmable Read-Only Memory)), ASIC (Application Specific Integrated Circuit) to generate an image 54 of the
10 AMPS interferer 20. A subtractor 55 subtracts the image 54 from the baseband signal 18 to produce an image-removed baseband signal 56. BER measurement module 57 then conducts a bit error analysis on the image-removed baseband signal 56 and the resulting ratio is applied to a corresponding input of the selector 52.

15

If the BER ratio from module 51 is lower than the BER ratio from module 57, this means that the image 54 from generator 53 is not a good representation of the AMPS interferer 20. In that case, the image-removed baseband signal 56 is ignored and baseband signal 18 is
20 selected by the selector 52 as the signal for further processing through the CDMA receiver 2.

If the BER ratio from module 51 is larger than the BER ratio from module 57, this means that at least a portion of the AMPS
25 interferer 20 has been successfully cancelled from the baseband signal 18, and that the quality of the communication has been improved. When

the BER ratio is sufficiently low and, therefore, the signal-to-noise ratio is sufficiently high, the power of transmission can be reduced, hence increasing the capacity and range of the cellular telephone system and the mobile station battery duration.

5

Many images of the AMPS interferer 20 can be generated through a series of image generators 1, 2, ... , X. As an example, parallel images can be produced for:

- 10 - various amplitudes of the AMPS interferer;
- various phases of the AMPS interferer;
- replacing the silent speech by AMPS signals representing
15 background noise or actual voice (inasmuch as there is a
possibility to identify known patterns that are worthwhile to
generate in this context);
- etc.

20

For each image, a subtractor such as 55 subtracts the image from the baseband signal 18 to produce an image-removed baseband signal. A BER measurement module such as 57 then conducts a bit error analysis on the image-removed baseband signal and the
25 resulting ratio is applied to a corresponding input of the selector 52. The selector 52 selects the signal having the lowest BER ratio amongst the

baseband signal 18 and the image-removed baseband signals as the output signal 58 for further processing through the CDMA receiver 2 (Figure 1).

5 CDMA signals comprise frames each having a duration of a few milliseconds. Normally, bit error analysis will be conducted through the modules such as 51 and 57 every frame. For example, since the AMPS interferer 20 carries voice and voice activity can change at any time, this is worthwhile repeating the above described process every
10 CDMA frame.

The AMPS interferer cancelling process can be greatly improved by means of a feedback loop between the BER measurement module and the image generator. Figure 6 illustrates such an
15 implementation, to remove components of the AMPS interferer 20 from the baseband signal 18 (Figure 1).

Again, the baseband signal 18 is first produced by processing the wideband signal 15 of Figure 1 through the CDMA receiver
20 chain 50, including the filters 16 and convolution 17 (see the CDMA receiver 2 of Figure 1).

Bit error analysis is performed in BER (Bit Error Rate) measurement module 60 on the baseband signal 18 and the resulting
25 BER ratio is applied to a corresponding input of a selector 61.

At least one image generator 62 uses the scheme of Figure 4 or a corresponding digital implementation such as software, firmware (e.g. PROM (Programmable Read-Only Memory)), ASIC (Application Specific Integrated Circuit) to generate an image 63 of the AMPS interferer 20. A subtractor 64 subtracts the image 63 from the baseband signal 18 to produce an image-removed baseband signal 65. BER measurement module 66 then conducts a bit error analysis on the image-removed baseband signal 65, and the resulting BER ratio is applied to a corresponding input of the selector 61.

Again, if the BER ratio from module 60 is lower than the BER ratio from module 66, this means that the image 63 from the generator 62 is not a good representation of the AMPS interferer 20. In that case, the image-removed baseband signal 65 is ignored and baseband signal 18 is selected by the selector 61 as the signal 68 for further processing through the CDMA receiver 2 of Figure 1.

If the BER ratio from module 60 is larger than the BER ratio from module 66, this means that at least a portion of the AMPS interferer 20 has been successfully cancelled from the baseband signal, and that the quality of the communication has been improved. In this case, the image-remove baseband signal 65 is selected by the selector 61 as the signal 68 for further processing through the CDMA receiver. As indicated earlier in this description, when the BER ratio is sufficiently low and, therefore, the signal-to-noise ratio is sufficiently high, the power of

transmission can be reduced, hence increasing the capacity and range of the cellular telephone system and the mobile station battery duration.

5 In the implementation of Figure 6, a feedback loop 67 is connected between the output of the BER measurement module 66 and the image generator 62 and eventually between the output of the selector 61 and the image generator 62 (see 69). The feedback loop 67 (and eventually 69) will provide the image generator 62 with an error signal to enable this generator 62 to vary as required the amplitude or phase (or
10 other characteristics such as the frequency content) of the image 63 in order to closely track the characteristics of the real AMPS interferer 20. Obviously, the amplitude or phase (or other parameter) of the image 63 can be varied by the generator 62 until the BER comparison in selector 61 falls in favour of the image-removed baseband signal 65. This is likely to
15 improve quality of the communication.

Obviously, feedback control of the generator 62 through the feedback loop 67 (and eventually 69) can be implemented through feedback control algorithms. Given the above information, it is believed
20 to be within the capacity of one of ordinary skill in the art to build such an algorithm capable of fulfilling the required conditions of operation.

It should be pointed out that it is possible to combine:
- many image generators and corresponding BER measurement
25 modules as illustrated in Figure 5; with

- at least one image generator and BER measurement module with feedback loop as illustrated in Figure 6.

Those of ordinary skill in the art will appreciate that the present invention also applies to interferers, narrowband or not, other than AMPS, for example GSM, CDMA, TDMA or any other type of radio signal (for example harmonics from another frequency bandwidth used for another telecommunication service, etc.) and having characteristics that are sufficiently known to enable development and production of corresponding images.

In the case of digital wireless technologies used for data communication, especially in circuit switched mode, the present invention would apply quite well when there is no actual data being sent. In the case where encryption is used, for silent voice or silent data, trial and error or full decoding will be required to find images that are worthwhile.

Also, just a word to mention that application is not limited to CDMA communication systems and to voice signals and data. With communication systems other than CDMA, processing of the signal in the receiver chain can involve operations completely different from the above described despreading scheme.

Finally, the present invention could be adapted to communication systems other than a cellular telephone system, for example a satellite data communication system.

Although the present invention has been described
hereinabove by way of a preferred embodiment thereof, this embodiment
can be modified at will, within the scope of the appended claims, without
5 departing from the spirit and nature of the subject invention.

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WHAT IS CLAIMED IS:

1. A method for attenuating an interferer of substantially known spectrum in a communication signal which has been transmitted
5 through a transmission channel and processed through a signal-processing receiver chain, said method comprising:

generating, from the substantially known spectrum and independently of the communication signal, at least one image representative of a replica of the interferer after processing through the
10 signal-processing receiver chain;

subtracting the image from the processed communication signal to produce a subtraction signal;

calculating a quality-indicative parameter of the processed communication signal;

15 computing said quality-indicative parameter for the subtraction signal; and

selecting, in relation to the quality-indicative parameters, one of the processed communication signal and subtraction signal for further processing through the receiver.

20

2. A method for attenuating an interferer as recited in claim 1, wherein:

generating at least one image comprises producing, from the substantially known spectrum and independently of the communication
25 signal, a plurality of different images each representative of a replica of the interferer after processing through the signal-processing receiver chain;

said subtracting comprises, for each image, subtracting the image from the processed communication signal to produce a corresponding subtraction signal;

said computing comprises computing said quality-
5 indicative parameter for every subtraction signal; and

said selection comprises selecting, in relation to the quality-indicative parameters, one of the processed communication signal and subtraction signals for further processing through the receiver.

10 3. A method for attenuating an interferer as recited in claim 1, wherein:

generating at least one image comprises feedback controlling, in relation to the quality-indicative parameter of the subtraction signal, at least one feature of the image to improve said quality-indicative
15 parameter of the subtraction signal.

4. A method for attenuating an interferer as recited in claim 3, wherein said at least one feature is an amplitude of the image.

20 5. A method for attenuating an interferer as recited in claim 3, wherein said at least one feature is a phase of the image.

6. A method for attenuating an interferer as recited in claim 1, wherein generating at least one image comprises:

25 generating said replica of the interferer; and
processing said replica through transfer functions

reproducing the signal-processing receiver chain to produce a processed interferer replica.

7. A method for attenuating an interferer as recited in
5 claim 6, wherein generating at least one image further comprises
amplifying the processed interferer replica to produce the image.

8. A method for attenuating an interferer as recited in
claim 1, wherein generating said replica comprises generating a silent
10 replica of the interferer including no voice or data component.

9. A method for attenuating an interferer as recited in
claim 1, wherein:

- the interferer is a narrowband interferer;
- 15 - the communication signal is a spread spectrum signal;
- the signal-processing receiver chain incorporates a despreading scheme whose function is to convert the spread spectrum signal to a despread signal; and
- generating at least one image comprises:
20 - producing a replica of the narrowband interferer;
- processing said replica through transfer functions reproducing the signal-processing receiver chain including the despreading scheme.

25 10. A method for attenuating an interferer as recited in
claim 9, wherein the narrowband inteferer is an AMPS interferer, and the

spread spectrum signal is a CDMA spread spectrum signal.

11. A method for attenuating an interferer as recited in
claim 10, wherein the quality-indicative parameters are BER
5 measurements of the despread signal and subtraction signal.

12. A method for attenuating an interferer as recited in
claim 10, wherein producing a replica of the AMPS interferer comprises
producing a silent replica of the AMPS interferer including no voice or data
10 component.

13. A method for attenuating an interferer as recited in
claim 6, comprising both generating said replica of the interferer and
processing said replica through transfer functions are conducted through
15 through a digital implementation.

14. A method for attenuating an interferer as recited in
claim 13, wherein said digital implementation is selected from the group
consisting of software, firmware and ASIC.
20

15. A method for attenuating an interferer from a
communication signal which has been transmitted through a transmission
channel and processed through a signal-processing receiver chain, said
method comprising:

25 generating a plurality of images of the interferer having
different features;

for each interferer image, subtracting said interferer image from the processed communication signal to produce a corresponding subtraction signal;

calculating a quality-indicative parameter of the
5 processed communication signal;

computing said quality-indicative parameter for every subtraction signal; and

selecting, in relation to the quality-indicative parameters, one of the processed communication signal and subtraction signals for
10 further processing through the receiver.

16. A method for attenuating an interferer as defined in claim 15, wherein said features of the images comprise amplitudes of said images.
15

17. A method for attenuating an interferer as recited in claim 15, wherein said features of the images comprise phases of said images.

20 18. A method for attenuating an interferer as recited in claim 15, wherein:

- the interferer is selected from the group consisting of a narrowband AMPS interferer, a TDMA interferer and a GSM interferer;
- 25 - the communication signal is a CDMA spread spectrum signal;
- the signal-processing receiver chain incorporates a despreading

scheme whose function is to convert the CDMA spread spectrum signal to a despread baseband signal; and

- the quality-indicative parameters are BER measurements of the despread baseband signal and subtraction signals.

5

19. A method for attenuating an interferer as recited in claim 15, wherein generating one of said images comprises feedback controlling, in relation to the quality-indicative parameter of one of the subtraction signals corresponding to said one image, the feature of said one image in view of improving the quality-indicative parameter of said one subtraction signal.

20. A method for attenuating an interferer as recited in claim 19, wherein feedback control of the feature of said one image comprises controlling the feature of said one image also in relation to said selection to improve the quality-indicative parameter of said one subtraction signal until said subtraction signal is selected for further processing through the receiver.

21. A method for attenuating an interferer from a communication signal which has been transmitted through a transmission channel and processed through a signal-processing receiver chain, said method comprising:

- generating an image of the interferer;
- subtracting the interferer image from the processed communication signal to produce a subtraction signal;

calculating a quality-indicative parameter of the processed communication signal;

computing said quality-indicative parameter for the subtraction signal; and

5 selecting, in relation to the quality-indicative parameters, one of the processed communication signal and subtraction signal for further processing through the receiver;

wherein generating an image of the interferer comprises feedback controlling, in relation to the quality-indicative parameter of the subtraction
10 signal, at least one feature of the image in view of improving said quality-indicative parameter of the subtraction signal.

22. A method for attenuating an interferer as recited in claim 21, wherein feedback control of at least one feature of the image
15 comprises controlling said at least one feature also in relation to said selection to improve the quality-indicative parameter of the subtraction signal until said subtraction signal is selected for further processing through the receiver.

20 23. A method for attenuating an interferer as recited in claim 21, wherein:

- the interferer is selected from the group consisting of: a narrowband AMPS interferer, a TDMA interferer and a GSM interferer;
- 25 - the communication signal is a CDMA spread spectrum signal;
- the signal-processing receiver chain incorporates a despreading

scheme whose function is to convert the CDMA spread spectrum signal to a despread baseband signal; and

- the quality-indicative parameters are BER measurements of the despread baseband signal and subtraction signal.

5

24. A device for attenuating an interferer of substantially known spectrum in a communication signal which has been transmitted through a transmission channel and processed through a signal-processing receiver chain, said device comprising:

10

a generator of at least one image representative of a replica of the interferer after processing through the signal-processing receiver chain, said generator having image generating means responsive to the substantially known spectrum of the interferer but having no connection to the communication signal;

15

a subtractor of the image from the processed communication signal to produce a subtraction signal;

a first calculator of a quality-indicative parameter of the processed communication signal;

20

a second calculator of said quality-indicative parameter for the subtraction signal; and

a selector of one of the processed communication signal and subtraction signal in relation to the quality-indicative parameters, for further processing through the receiver.

25

25. A device for attenuating an interferer as recited in claim 24, wherein said image generating means comprises:

a sub-generator of the interferer replica; and
a processor of the interferer replica from the sub-generator, said processor comprising transfer functions reproducing the signal-processing receiver chain.

5

26. A device for attenuating an interferer as recited in claim 25, wherein the image generating means further comprises an amplifier supplied with the processed interferer replica from the processor to apply a gain to said processed interferer replica and thereby produce the image.

10

27. A device for attenuating an interferer as recited in claim 24, wherein said replica is a silent replica of the interferer including no voice or data component.

15

28. A device for attenuating an interferer as recited in claim 24, wherein:

20

- the interferer is a narrowband interferer;
- the communication signal is a spread spectrum signal;
- the signal-processing receiver chain incorporates a despreading scheme whose function is to convert the spread spectrum signal to a despread signal; and
- the generator comprises:
 - a sub-generator of a replica of the narrowband interferer;
 - a processor of said narrowband interferer replica,

25

said processor comprising transfer functions
reproducing the signal-processing receiver chain
incorporating the despreading scheme.

5 29. A device for attenuating an interferer as recited in
claim 28, wherein the narrowband interferer is an AMPS interferer, and the
spread spectrum signal is an CDMA spread spectrum signal.

10 30. A device for attenuating an interferer as recited in
claim 29, wherein the first and second calculators comprises respective
BER measurement means.

15 31. A device for attenuating an interferer as recited in
claim 29, wherein the narrowband interferer replica sub-generator
comprises a silent replica producing means.

20 32. A device for attenuating an interferer as recited in
claim 25, wherein said sub-generator and said processor comprise a
digital implementation.

25 33. A device for attenuating an interferer as recited in
claim 32, wherein said digital implementation is selected from the group
consisting of: software, firmware and ASIC.

34. A device for attenuating an interferer of substantially
known spectrum in a communication signal which has been transmitted

through a transmission channel and processed through a signal-processing receiver chain, said device comprising:

means for generating, in relation to the substantially known spectrum but independently of the communication signal, at least
5 one image representative of a replica of the interferer after processing through the signal-processing receiver chain;

means for subtracting the image from the processed communication signal to produce a subtraction signal;

means for calculating a quality-indicative parameter of
10 the processed communication signal;

means for calculating said quality-indicative parameter for the subtraction signal; and

means for selecting, in relation to the quality-indicative parameters, one of the processed communication signal and subtraction
15 signal for further processing through the receiver.

35. A device for attenuating an interferer from a communication signal which has been transmitted through a transmission channel and processed through a signal-processing receiver chain, said
20 device comprising:

a generator of a plurality of images of the interferer having different features;

for each interferer image, a subtractor of said interferer image from the processed communication signal to produce a
25 corresponding subtraction signal;

a first calculator of a quality-indicative parameter of the

processed communication signal;

a second calculator of said quality-indicative parameter
for every subtraction signal; and

a selector of one of the processed communication signal
5 and subtraction signals in relation to the quality-indicative parameters, for
further processing through the receiver.

36. A device for attenuating an interferer as defined in
claim 35, wherein said features of the images comprises amplitudes of
10 said images.

37. A device for attenuating an interferer as recited in
claim 35, wherein said features of the images comprise phases of said
15 images.

38. A device for attenuating an interferer as recited in
claim 35, wherein:

- the interferer is selected from the group consisting of a
narrowband AMPS interferer, a TDMA interferer and a GSM
20 interferer;
- the communication signal is a CDMA spread spectrum signal;
- the signal-processing receiver chain incorporates a despreading
scheme whose function is to convert the CDMA spread
spectrum signal to a despread baseband signal; and
- 25 - the first and second calculators comprise respective BER
measurement modules which, in operation, supply BER

measurements of the despread baseband signal and subtraction signal.

39. A device for attenuating an interferer as recited in
5 claim 35, wherein said generator comprises a feedback control of the feature of one of said images in relation to the quality-indicative parameter of the subtraction signal corresponding to said one image, in view of improving the quality-indicative parameter of said one subtraction signal.

10 40. A device for attenuating an interferer as recited in claim 39, wherein said feedback control is also responsive to the selection by said selector.

41. A device for attenuating an interferer from a
15 communication signal which has been transmitted through a transmission channel and processed through a signal-processing receiver chain, said device comprising:

means for generating a plurality of images of the interferer having different features;

20 for each interferer image, means for subtracting said interferer image from the processed communication signal to produce a corresponding subtraction signal;

means for calculating a quality-indicative parameter of the processed communication signal;

25 means for computing said quality-indicative parameter for every subtraction signal; and

means for selecting, in relation to the quality-indicative parameters, one of the processed communication signal and subtraction signals for further processing through the receiver.

5 42. A device for attenuating an interferer from a communication signal which has been transmitted through a transmission channel and processed through a signal-processing receiver chain, said device comprising:

 a generator of an image of the interferer;
10 a subtractor of the interferer image from the processed communication signal to produce a subtraction signal;
 a first calculator of a quality-indicative parameter of the processed communication signal;
 a second calculator of said quality-indicative parameter
15 for the subtraction signal; and
 a selector of one of the processed communication signal and subtraction signal in relation to the quality-indicative parameters, for further processing through the receiver;
 wherein the generator comprises a feedback control of at least one feature
20 of the image in relation to the quality-indicative parameter of the subtraction signal, in view of improving said quality-indicative parameter of the subtraction signal.

 43. A device for attenuating an interferer as recited in
25 claim 42, wherein said feedback control is responsive to the selection by said selector.

44. A device for attenuating an interferer as recited in claim 42, wherein:

- 5 - the interferer is selected from the group consisting of a narrowband AMPS interferer, a TDMA interferer and a GSM interferer;
- the communication signal is a CDMA spread spectrum signal;
- the signal-processing receiver chain incorporates a despreading scheme whose function is to convert the CDMA spread spectrum signal to a despread baseband signal; and
- 10 - the first and second calculators comprise respective BER measurement modules.

45. A device for attenuating an interferer from a communication signal which has been transmitted through a transmission channel and processed through a signal-processing receiver chain, said device comprising:

- means for generating an image of the interferer;
- means for subtracting the interferer image from the processed communication signal to produce a subtraction signal;
- 20 means for calculating a quality-indicative parameter of the processed communication signal;
- means for calculating said quality-indicative parameter for the subtraction signal; and
- 25 means for selecting, in relation to the quality-indicative parameters, one of the processed communication signal and subtraction

signal for further processing through the receiver;
wherein the means for generating an image of the interferer comprises
means for feedback controlling, in relation to the quality-indicative
parameter of the subtraction signal, at least one feature of the image in
5 view of improving said quality-indicative parameter of the subtraction
signal.

46. A method of generating an image of an interferer of
substantially known spectrum for use in attenuating said interferer in a
10 communication signal which has been transmitted through a transmission
channel and processed through a signal-processing receiver chain, said
method comprising:

generating a replica of the interferer from the
substantially known spectrum and independently of the communication
15 signal; and

processing the interferer replica through transfer
functions reproducing the signal-processing receiver chain in view of
producing the interferer image.

47. A method of generating an interferer image as
recited in claim 46, further comprising applying a gain to the processed
interferer replica.

48. A method of generating an interferer image as
25 recited in claim 46, comprising conducting both generating of a interferer
replica and processing of the interferer replica through a digital

implementation.

49. A method of generating an interferer image as
recited in claim 48, further comprising selecting the digital implementation
5 from the group consisting of software, firmware and ASIC.

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ABSTRACT OF THE DISCLOSURE

5 The method and device attenuate an interferer of
substantially known spectrum in a communication signal which has been
transmitted through a transmission channel and processed through a
signal-processing receiver chain. In these method and device, the
substantially known spectrum is used to generate, independently of the
communication signal, at least one image representative of a replica of the
10 interferer after processing through the signal-processing receiver chain.
The generated image is subtracted from the processed communication
signal to produce a subtraction signal, and quality-indicative parameters
of the processed communication signal and the subtraction signal(s) are
calculated. Finally, the quality-indicative parameters are used to select
15 one of the processed communication signal and subtraction signal(s) for
further processing through the receiver. When a plurality of images are
generated, these images have different features, for instance different
amplitudes or phases. At least one image can be feedback controlled in
relation to the quality-indicative parameter of the subtraction signal
20 corresponding to this image, in view of improving the quality-indicative
parameter of this subtraction signal. This feedback control can also be
responsive to the signal selection to improve the quality-indicative
parameter of the subtraction signal until the latter signal is selected for
further processing through the receiver.

FIG: 1

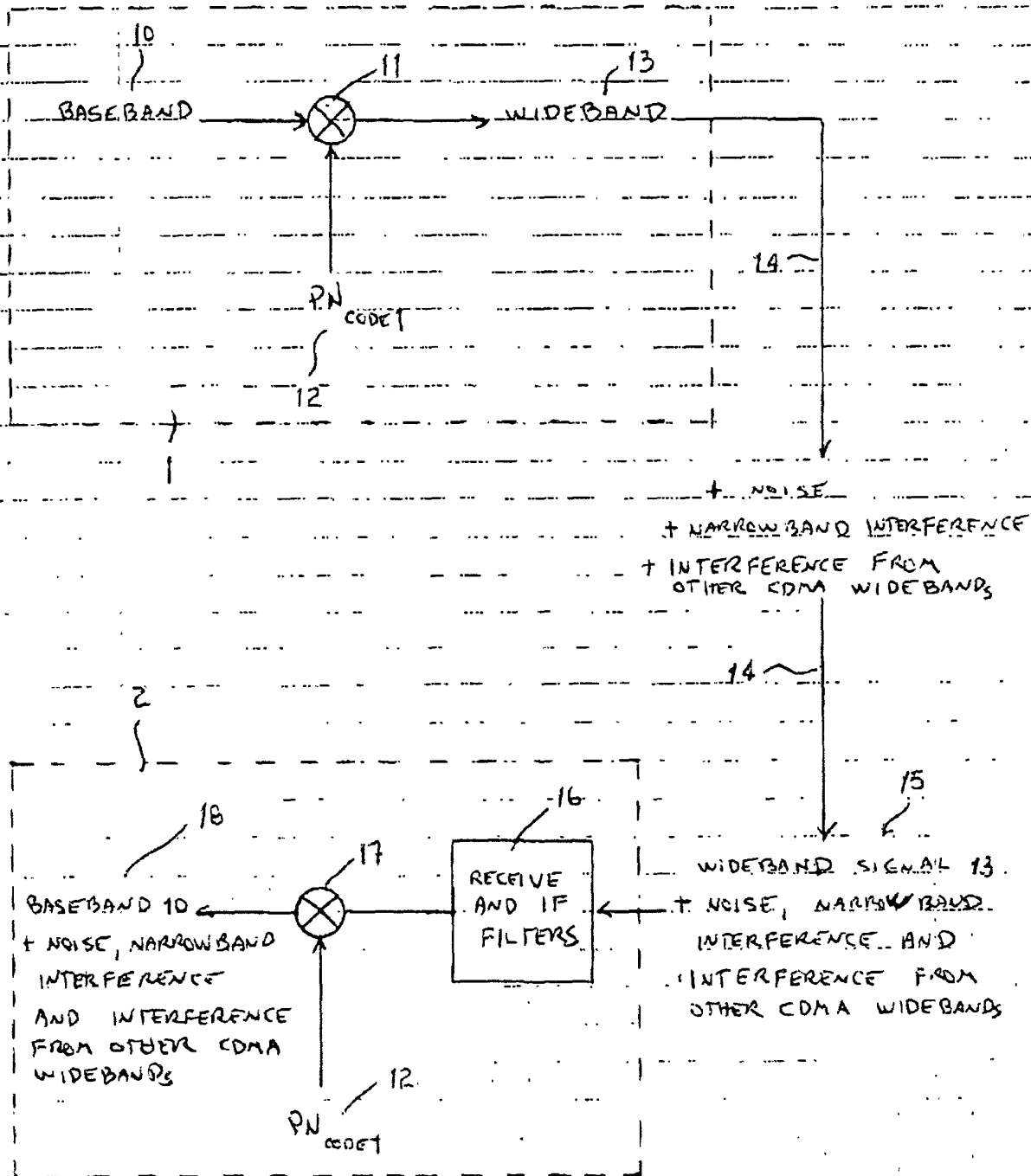


FIG: 2

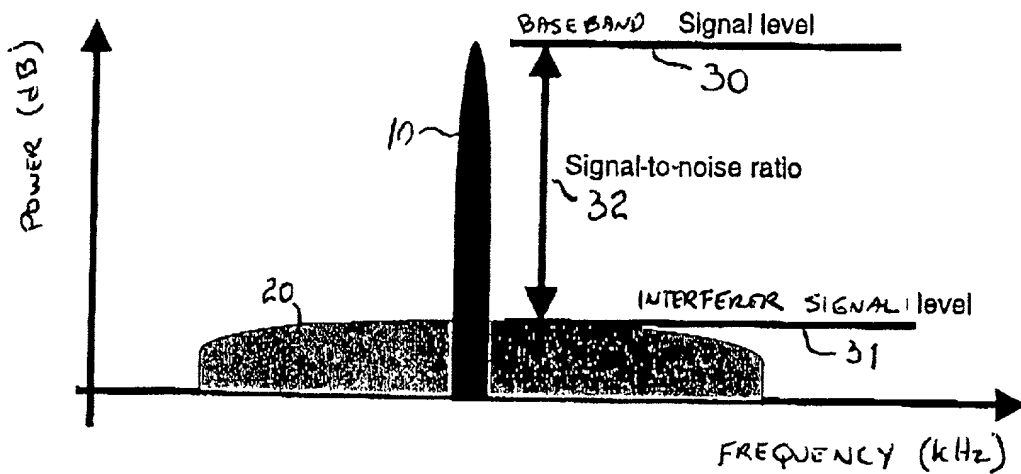
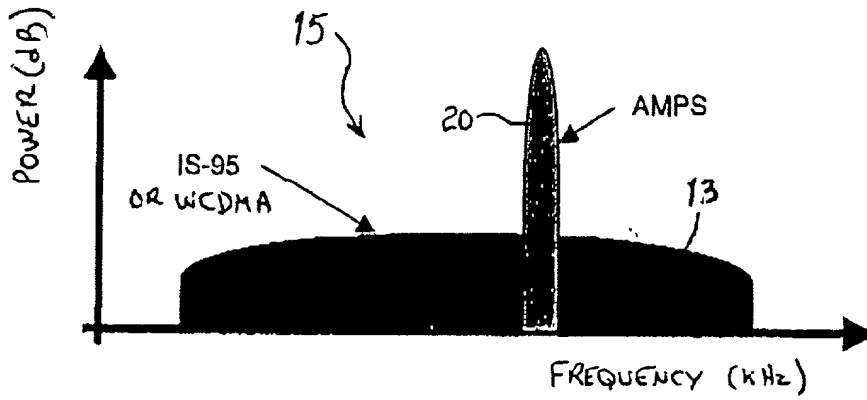
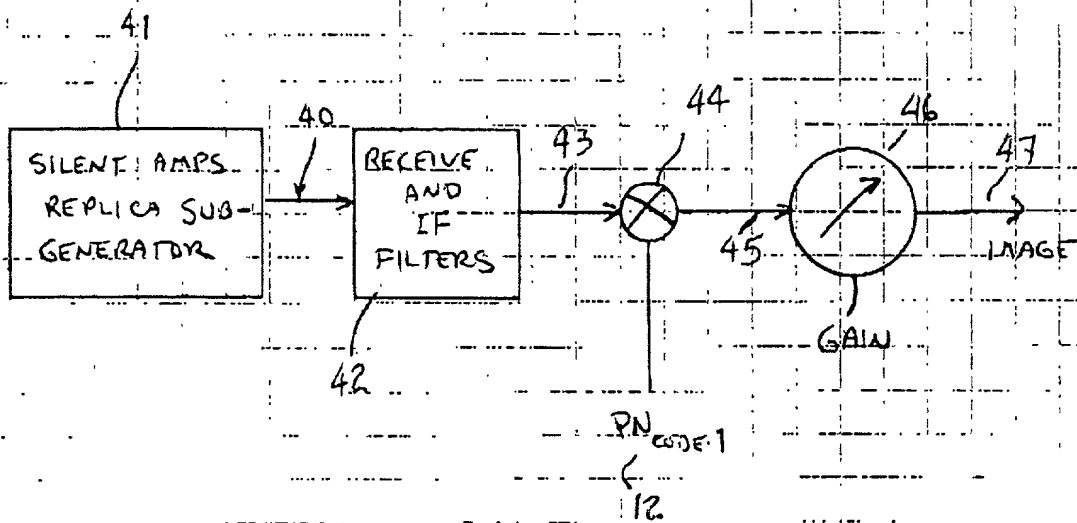


FIG: 3

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FIG: 4



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FIG. 5

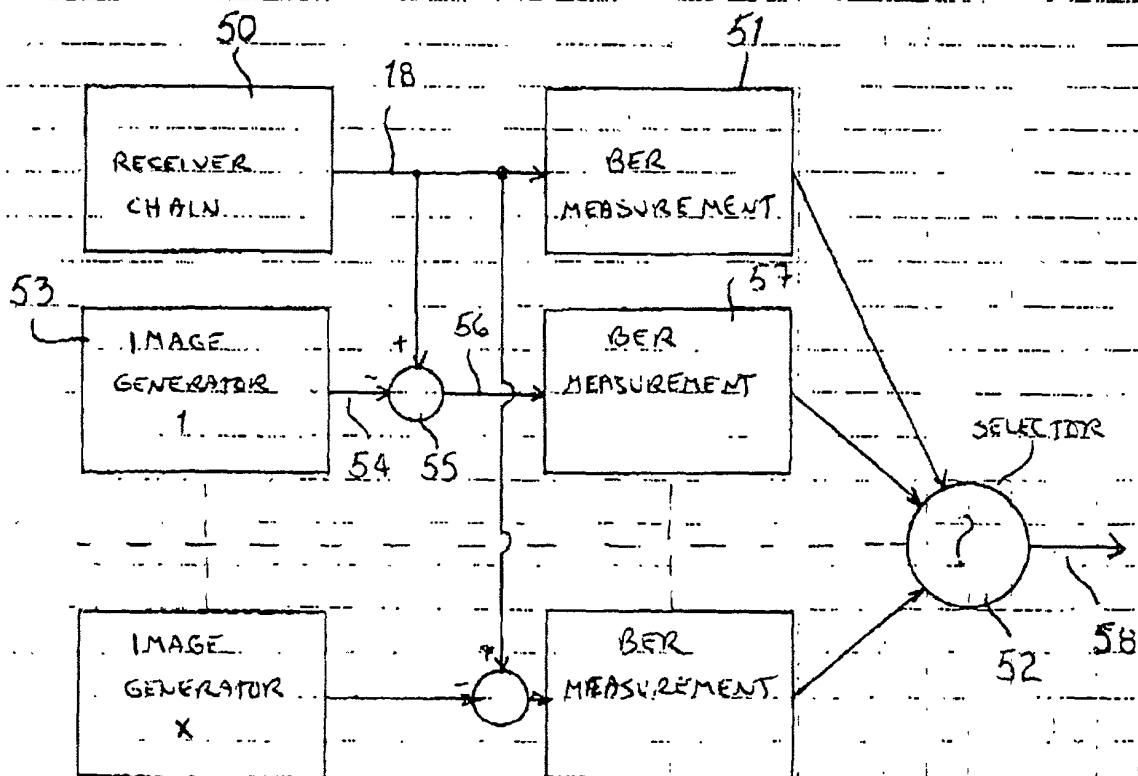
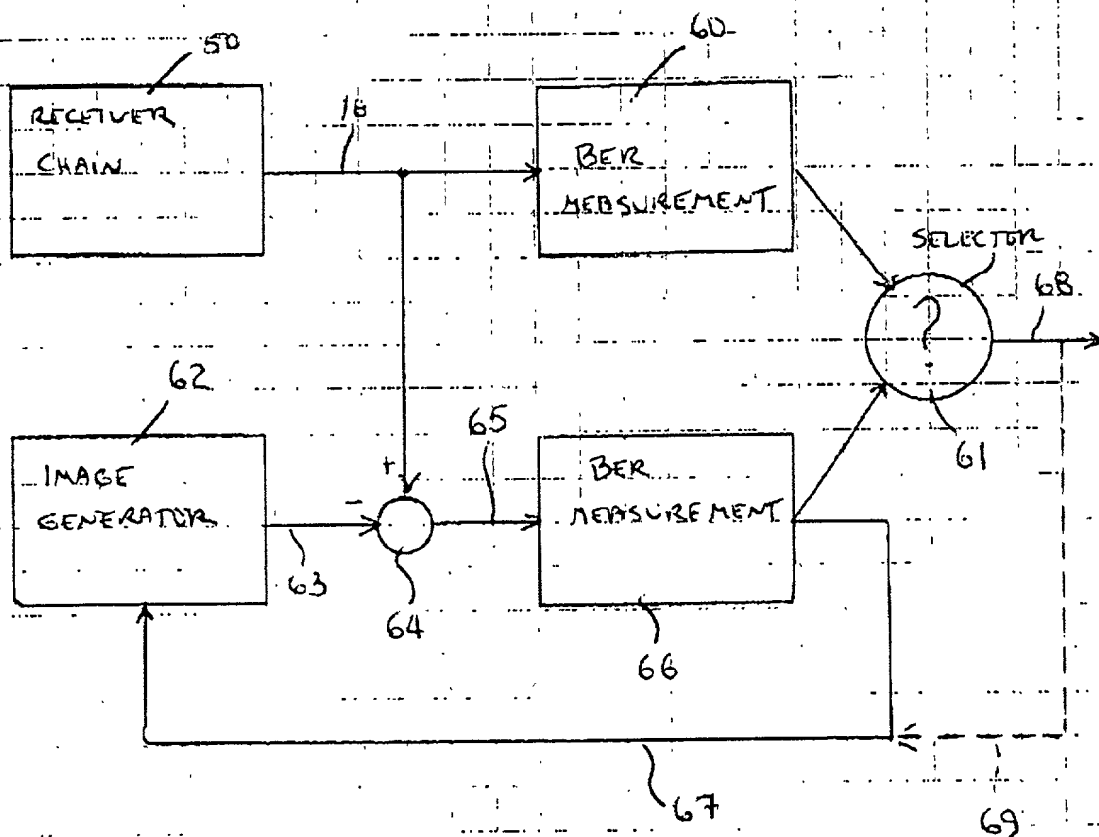


FIG. 6



**RULES 63 AND 67 (37 C.F.R. 1.63 and 1.67)
DECLARATION AND POWER OF ATTORNEY**

FOR UTILITY/DESIGN/CIP/PCT NATIONAL APPLICATIONS

As a below named inventor, I hereby declare that:

My residence, post office address and citizenship are as stated below next to my name;
and

I believe that I am the original, first and sole inventor (if only one name is listed below)
or an original, first and joint inventor (if plural names are listed below) of the subject
matter which is claimed and for which a patent is sought on the invention entitled:

**METHOD AND DEVICE FOR ATTENUATING AN INTERFERER FROM A
COMMUNICATION SIGNAL**

the specification of which: (mark only one)

- X (a) is attached hereto.
 (b) was filed on _____ as Attorney Docket No. 27950-453
 and was amended on _____ (if applicable)
 (c) was filed as PCT International Application No. PCT/ _____
 on _____ and was amended on _____ (if applicable)
 (d) was filed on _____ as Application Serial No. _____
 and was issued a Notice of Allowance on _____

I hereby state that I have reviewed and understand the contents of the above identified
specification, including the claims as amended by any amendment referred to above or as
allowed as indicated above.

I acknowledge the duty to disclose all information known to me to be material to the
patentability of this application as defined in 37 CFR § 1.56. If this is a continuation-in-
part (CIP) application, insofar as the subject matter of each of the claims of this application
is not disclosed in the prior United States application in the manner provided by the first
paragraph of 35 U.S.C. § 112, I acknowledge the duty to disclose to the Office all
information known to me to be material to patentability of the application as defined in 37
CFR § 1.56 which became available between the filing date of the prior application and the
national or PCT international filing date of this CIP application.

I hereby claim foreign priority benefits under 35 U.S.C. § 119/365 of any foreign
application(s) for patent or inventor's certificate listed below and have also identified

09662740-091500

PATENT APPLICATION
ATTORNEY DOCKET NO.: 27950-453
Client Docket No.: LMC 2000-032

below any foreign application for patent or inventor's certificate filed by me or my assignee disclosing the subject matter claimed in this application and having a filing date (1) before that of the application on which my priority is claimed or, (2) if no priority is claimed, before the filing date of this application:

PRIOR FOREIGN PATENTS

<u>Number</u>	<u>Country</u>	<u>Month/Day/Year</u> <u>Filed</u>	<u>Date first laid-</u> <u>open or</u> <u>Published</u>	<u>Date</u> <u>patented or</u> <u>Granted</u>	<u>Priority Claimed</u>	
					<u>Yes</u>	<u>No</u>
_____	_____	_____	_____	_____	_____	_____
_____	_____	_____	_____	_____	_____	_____

I hereby claim the benefit under 35 U.S.C. § 119(e) of any United States provisional application(s) listed below:

PROVISIONAL APPLICATIONS

<u>Application No. (series code/serial no.)</u>	<u>Month/Day/Year Filed</u>
_____	_____

I hereby claim the benefit under 35 U.S.C. § 120/365 of any United States application(s) listed below and PCT international applications listed above or below:

PRIOR U.S. OR PCT APPLICATIONS

<u>Application No. (series code/serial no.)</u>	<u>Month/Day/Year Filed</u>	<u>Status (pending, abandoned, patented)</u>
_____	_____	_____

I hereby appoint:

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PATENT APPLICATION
ATTORNEY DOCKET NO.: 27950-453
Client Docket No.: LMC 2000-032

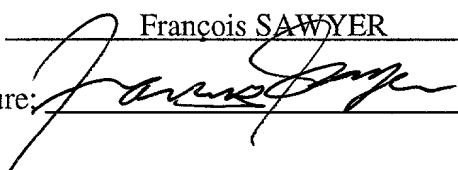
as my attorneys and/or agents, with full power of substitution and revocation, to prosecute this application and to transact all business in the United States Patent and Trademark Office connected therewith, and to file and prosecute any international patent application filed thereon before any international authorities under the Patent Cooperation Treaty, and I hereby authorize them to act and rely on instructions from and communicate directly with the person/assignee/attorney/firm/organization who/which first sent this case to them and by whom/which I hereby declare that I have consented after full disclosure to be represented unless/until I instruct them in writing to the contrary.

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I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code, and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

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(FOR ADDITIONAL INVENTORS, check here ☐ and add additional sheet for inventor information regarding signature, name, date, citizenship, residence and address)

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